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A method to select an IT system for a logistics company. A highly efficient infrastructure to respond, change and to drive innovation

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Abstract

The purpose of this article is to present a functionality analysis for systems that support business companies as well as a well-known problem of multi-criteria selection of such systems (for any logistics company). It also identifies a formal mathematical model and a practical way to solve it.

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Keywords: functionality analysis, multicriteria selection method, logistics system

1. Introduction

Many new advancements are placing great demands on IT infrastructure. The next-generation decision-makers need simple but adaptive systems and new architectures, able to respond to any possible changes. Our IT driven society, widely defined by data consumption, storage capabilities and software environment, struggles to maintain the level of growth (obtaining new processing ways). Logistics-based issues are now the “bottle-neck” problems for many systems. But there is still room for improvement. Designing an optimal business IT system can significantly reduce costs while improving customer satisfaction levels (dissatisfaction is caused, in some cases, by the use of less than

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optimal logistics systems). Many information systems may be supported by proper computer systems. The quality of such a solution is a vital factor and essentially determines the position of the company in a competitive market. Therefore, one of the most important stages in the implementation of such systems is to identify the needs of such systems, their proper selection and company positioning. The article presents a multi-criteria method for such selection on the background of different classes of those systems implemented in companies.

2. Functionality analysis for systems implemented in logistics companies

For the purpose of business IT support, logistics companies use many different systems. The following classes of software systems are the most popular:

- systems related to partial areas of business (accounting systems, logistics planning, finance and accounting, HR systems, etc.)
- Manufacture Resource Planning / Enterprise Resource Planning - integrated software used to collect, store, manage and interpret data from business activities,
- SCM systems - used in supply chains management,
- WMS systems - used in storage capabilities management.

There are many significant differences between those systems. For example, MRP systems based on material specifications, inventory information and a schedule of activities designate the material needs. It should be noted, however, that further evolution to the MRP II allows us to plan sale of services, or personnel and finance management. That kind of systems allows us to process data using the Internet. Cutting-edge integrated systems called ERP use the methodology of MRPII improved by many new components such as cash flow management, financial analysis, business intelligence, workflow management. ERP systems are also known as MRPIII (Money Resource Planning) or MRP II Plus (an extension of MRP II with the financial module). The main modules of ERP systems are:

- Storage handling
- Inventory management
- Supply tracking
- Production planning / scheduling services
- Sales of services
- Customer Relationship Management
- Accounting
- Finance
- Human Resource Management

The latest version of ERP systems is provided with a functionality in the field of customer management. It may also offer the possibility to access many web services, making use of the B2B (Business to Business) and B2C (Business to Customer) concepts. Many systems implemented in companies that provide logistics services make use of new solutions and technologies. For example, the so-called cloud computing where all shared resources, software and information are provided over a network (allowing increased mobility with any device). The biggest and at the same time the newest challenge for MRP/ERP systems is an intuitive access to knowledge extracted from databases and data collections, (using all possible means of presentation and visualization). Commercial MRP / ERP systems available on the market differ in price, implementation method, scope of tasks performed, modularity, matching the information needs and usability.

SCM is another system used in logistics to provide and improve supply chain management by supporting procurement, production and sale processes. In many SCM systems, it is possible to develop a model of supply network (with all its limitations) and on this basis to synchronize activities and plan the flow of materials through the supply chain (allowing an adjustment between supply to demand and delivery management plans). Frequently, SCM systems are complementary tools for ERP. Thanks to adapt supply to demand, and manages the delivery plans. SCM systems are often complementary tools for ERP.

A computerized warehouse management system (WMS) is a very important tool applied to control the company resources by monitoring products movement in the warehouse. Many of them involve warehouse infrastructure, tracking and communication systems, optimization of traffic modes, the ability to exchange data with different systems and operators. Warehouse management systems may identify any product using barcode scanners, radio-frequency

identification, etc. and monitor its flow. WMS systems are individualized to the specifics of the company in which they are implemented. These systems make it possible to manage any number of warehouses, distribution of warehouses in different areas, classes and warehouse space. WMS systems often cooperate with MRP / ERP systems.

MRP / ERP, SCM, WMS and all other logistics systems require real-time data access (collected by a resource management system from internal and external data sources) to provide useful reports about the company. Therefore, some logistics systems use additional concepts like data warehouse systems or thematic data marts, which make it possible to use analytical processing (crucial for decision-making processes and decision support systems).

There is no easy way to select those systems. Usually, we can use two options:

- Construct and implement a totally new dedicated system for the company – which requires additional labour and resources, work reorganization, a new system vision, personnel training, new hardware and software, etc. That kind of implementation takes a relatively long time (there is a high probability that new technologies appear), and quite often it turns out that in the process many information needs become irrelevant.
- Implement an existing partial system (or its parts) – there is a need to integrate domain-specific systems to enhance IT support.

Before a company can implement any system, there is a need to examine how this logistics system was designed and how the different modules co-operate. The most critical aspect of the logistics system is the integration of all the individual logistics functions and information flows (Figure 1), different functions may operate independently from each other.

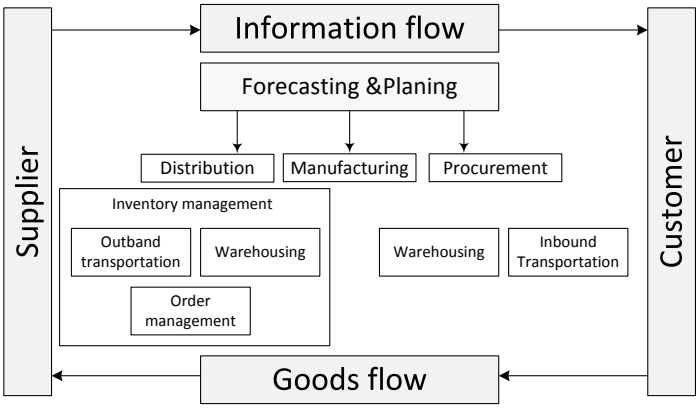

Fig. 1. Integration of logistics functions and information flows

This leads to sub-optimization of different functions and, consequently, high overall logistics costs, combined with low customer satisfaction levels and high levels of slow moving inventory.

To succeed with an implementation, one should use the so-called flexible methodologies, those that require practical knowledge in the area of software engineering.

3. Multi-criteria selection method for logistics company system (LCS)

Choosing the right information system for the company is often referred to as the so-called multi-criteria selection problem, where *n* possible implementation concepts (systems possible to implement) are evaluated. We define those systems as:

$$LCS_1, LCS_2, \ldots, LCS_n \tag{1}$$

where:

n – the number of evaluated solutions (systems).

In order to choose the best solution from LCS_i where $1 <= i <= n$, we need to specify a set of criteria for such a choice, defined as follows:

$$c_1, c_2, \ldots, c_m \tag{2}$$

where:

m – the number of criteria for the best solution selection in terms of those criteria.

Then the best choice should provide the optimum (minimum or maximum) for one of the so-called target functions:

$$F_l(c_1, c_2, \ldots, c_m) \wedge (1 \le l \le q) \tag{3}$$

where:

q – number of the the best solution selection functions in terms of the above (2) criteria.

In order to solve such a problem, special limitation, indicated by the formula number (4), is needed.

$$\underset{1 \le i \le n}{\forall} g_r(x_i) \mathrm{R}_r(w_r) \wedge (1 \le r \le p) \wedge (1 \le i \le n) \tag{4}$$

where:

p – number of choice restrictions for the solution from the formula number (1),

$\mathrm{R_r}$ – restriction defining relationship r (for example $<, \le, >, \ge, =, \neq$, similar, etc.),

w_r – restriction value r.

That task (described by formulas (1), (2), (3), (4)) belongs to a class of multi-criteria selection problems. There are numerous methods to solve this problem, although in some cases, such methods are still being studied, for example a case in which there is a large number of F_l criteria (big l and $1 <= l <= q$, as well as $q > 2$) and restrictions g_r for $1 <= r <= m$ and $m > 2$ are nonlinear functions.

There are methods aimed to seek the best solution where the criteria cj $(1 <= j <= m)$ are known and can be quantified, when these criteria are independent from each other, if one can determine the weight (importance) of these criteria, when $q = 1$ and the function $F1$ is a linear function and when the g_r restrictions are linear functions too, etc. One of them is the multiple-criteria decision analysis which concerns many different patterns, structures, solutions and planning problems with the aim to support decision-makers (wherever there is no simple, straight solution). Decision making can be dealt with in many ways, for example choosing the best option or a group of good alternatives out of available ones. However, the article restrictions do not allow a full review of multi-criteria analysis method (there was no such intention or goal). That's why the selected one is a solution known in the literature as AHP (Analytic Hierarchy Process), a method of hierarchical analysis supporting decision-making processes. AHP provides tools to decompose complex decision-making problem and to create one final ranking of solutions (in terms of chosen criteria). There are four phases of the AHP method.

- Hierarchical representation of selection.
- Expert evaluation criteria.
- Representation of global and local preferences for each of the compared software systems.
- Classification of variants and representation of the optimal solution in terms of selection criteria.

The main feature that applies to the AHP method is a simple several variant expert assessment with a criteria hierarchy as well as the ability to verify the consistency of expert review by additional competence tests.

4. Implementation of a multi-criteria selection for logistics systems

In order to present the application of the AHP method (selecting a system for a logistics company), the following criteria were adopted.

- Functionality of the system to select *(criterion c_1)*.
- Hardware architecture necessary to operate the software *(criterion c_2).*
- System price *(criterion c_3).*
- Experience of the company offering the logistics information system *(criterion c_4)*.

- Contact with software provider *(criterion c_5)*.

The following functional systems criteria (opportunities) were considered:

- Merchandise management *(sub-criterion c_{11}).*
- Partners management *(sub-criterion c_{12}).*
- Place management *(sub-criterion c_{13}).*
- Task management *(sub-criterion c_{14}).*
- Employee management *(sub-criterion c_{15}).*
- Documenting and reporting *(sub-criterion c_{16}).*
- System modularity *(sub-criterion c_{17}).*

The selection was made for five systems available on the market, selected by experts and managers (Figure 2), presented according to the definitions in section 3 as LCS1, LCS2, ..., LCS5.

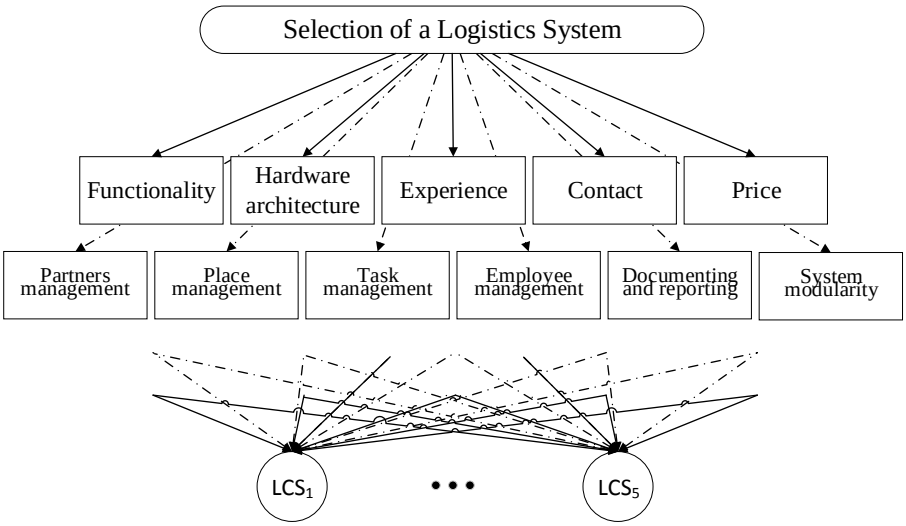

Fig. 2. The selection criteria for a logistics system

Selected experts (twelve local managers and scientists dealing with IT system issues) chose normalized weights for the criteria, presented in Table 1 as a normalized matrix with preference selection criteria (vector priorities).

Table 1. Preference matrix for the selection criteria

	Weight
c_1	0.45
c_2	0.06
c_3	0.17
c_4	0.03
c_5	0.29
SUM	1

In the same way local and global weights for sub-criteria were set (Table 2).

Table 2. The preference matrix for functionality criterion

Sub-criterion for c_1 criterion	Local weight	Global weight
Merchandise management (c_{11})	0.41	0.18
Partners management (c_{12})	0.18	0.08
Place management (c_{13})	0.09	0.04
Task management (c_{14})	0.06	0.03
Employee management (c_{15})	0.04	0.02
Documenting and reporting (c_{16})	0.20	0.09
System modularity (c_{17})	0.02	0.01

Regardless of the criterion weight, the experts evaluated the systems in pairs and the final ranking was established (Table 3)

Table 3. System ranking (own studies)

Ranking position	Evaluated system	Assessment ratio
I	LCS_2	0.2437
II	LCS_5	0.2116
III	LCS_3	0.1831
IV	LCS_1	0.1812
V	LCS_4	0.1804

Such analysis should involve further selection criteria to generate more accurate scenarios, to guide managers to an optimal decision on selection of an efficient logistics system.

5. Conclusions

The concept of logistics systems selection has become an important task for many companies which should pay more attention to how to select an appropriate LCS. The above article analyzes how to choose the best logical method. The sample implementation, presented in section 3, confirms the accuracy of the article and of the multi-criteria model for system selection. It shows not only the possibility of such selection (from many different levels of LCS), but also the opportunity to make it according to individual preferences and the ability to use the appropriate method for multi-criteria optimization.

A good LCS could optimize the logistics company functioning, effectiveness and competitive advantages on the market.

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